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Application of Markov Chain Model on Natural Disasters: A Case Study of Fire Outbreak

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ABSTRACT

Right from the beginning of life, the importance of fire cannot be over-emphasized as man embraces evolution which is accompanied by new innovations, discoveries and technology. Despite its importance, fire outbreak causes negative effects on human being and the society at large. Poor dissemination of information regarding fire disasters, causes of fire disaster, mitigating methods and risk management has led to an increase in exposure the society to greater risk. Therefore, there is a need to predict the location that a fire disaster is likely to occur using Markov chain. The study revealed that fire outbreaks can occur in any place and at a different magnitude, therefore, everybody has to be on guard. The finding also revealed that places that experienced fire disasters will still experience in the future if not properly managed. We recommended that the government should create awareness through advertisement programs, training centers, seminars and encourage the integration of fire disasters into the school curriculum to ensure sufficient and effective fire disaster mitigation and management.

KEYWORDS: *Markov chain, natural disasters, fire outbreak*

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INTRODUCTION

In recent years there has been a rapid growth in modernization, human knowledge and technology which has led to a corresponding increase in the interaction between a man his environment thus causing an environmental imbalance that triggers disasters directly or indirectly. Human activities cause a disturbance in ecological balance in the past decades (Pratibha & Arihna, 2015). A disaster is an unexpected phenomenon that disturbs the normal situations of a particular group of people or society whenever it occurs thereby causing a level of torment that exceed the ability of the affected community or society. According to Sena (2006), disaster is a situation where the affected community experiences a critical food scarcity and other vital necessities as a result of natural or man-made catastrophes to an extent that disrupt the normal function of the community involved thereby making survival difficult without intervention. The available resources of the affected community/society cannot withstand the negative effect of disaster. There are two types of disaster as Natural disaster and Man-made disaster. A natural disaster is a type of disaster caused by natural forces/ occurrences such as soil erosion, seismic activity, tectonic movement, air pressure and ocean current. They are natural processes is that cause loss of properties, economy, life, and environment. Natural disasters can also be seen as severe situations that occur without any prior warning as a result of negative effects of human activities which surpass the affected community's limited resources hence putting a stop to human's day to day activities thereby causing huge damages, destruction of properties, economy and environment, and loss of life. Natural disasters can be seen as a perpetual phenomenon that causes disturbance in the activities of man whenever they occur thereby steering serious damages and bring about negative effects on the economy and society at large. Subramani and Lone (2016) defined natural disaster as unwanted sudden occurrence trigger by natural forces that are greater than the human ability without any previous warning which brings about the serious disruption of economic activities, loss of life, properties and environment. A natural disaster can be divided into hydrological disasters, meteorological disasters, geological disasters, and biological disasters. While man-made disaster is a type of disaster that is generated by men such as technological disaster and sociological disaster (Jha, 2010). Disasters include earthquakes, volcanic eruption, rock falls, landslides, avalanches, floods, drought, storm, extreme temperature, wet mass movements, tsunami windstorms, diseases, fire outbreak etc.

Right from ages, fire has been part of the human being as man embraces evolution which is accompanied by new innovations and discoveries. Despite its importance, fire outbreak causes negative effects on human being and the society at large. The frequent occurrence of fire disasters has drawn the attention of the various stakeholders in society (Rahim, 2015), as it leads to loss of human life, wildlife, property and environment (Shuka, 2017).It can also be seen

as a situation where a burnable substance with a high amount of oxygen is subjected to heat gives rise to a fire outbreak. A fire outbreak is a type of disaster that resultsin heat, light and smoke whenever oxygen meets with inflammable fuel (Obasa, et, al., 2020). Fire can occur in any place based on petroleum properties, petroleum capacity, aeration, location of the fire and the weather condition available at that time which helps to determine the extent the fire will cover. Fire disasters can repeat in a particular place or location if not properly managed. Recent research has shown that lack of fire detecting systems, mitigating measures and safety management techniques have led to the death of many people. Poor dissemination of information regarding fire disasters, causes of fire disasters, mitigating methods and risk management has led to an increase in exposure the society to greater risk. Therefore, there is a need to predict the location that a fire disaster is likely to occur using the Markov chain.

Literature Review

Iyaj, Kolawoleand Anthony (2016) in vestigate the disaster, hazard destruction of property and loss of life. Descriptive statistics were used to analyze the data. They concluded that the occurrence of fire cannot be stopped but can be minimized through the use of designed and construction management techniques. Ilori, Sawa, and Gobir(2019) identify the causes of fire disasters using cause-and-effect analysis. The finding shows that bush burning, electrical fault arson, carelessness, alcohol and smoking are the basic causes of fire in both public and private schools. Addai et, al. (2016) discuss the trend of fire occurrence in Ghana from 2000 to 2013 and ways of preventing these incidents. They concluded that domestic fire disaster appears to be most occurrences with 41% of the total number of fire outcomes in the country. Scapini and Zuniga (2020) investigate the Markov chain approach to model reconstruction. They proposed a methodology for estimating the cost of hosing reconstruction by modeling the natural disaster that occurs as a Markov chain. The state of the conditions of the housing infrastructure and transition probability represents the probability of changing from one condition to another. The study shows that this approach allows policymakers to make a decision when facing the trade-off between current partial reconstruction and the future total reconstruction. Wang et, al. (2018), consider the application of the hidden Markov model in a dynamic risk assessment of rainstorms in Dalian, China. The rainstorm disaster data meteorological information were collected in Dalian ranging from 1976 to 2015. The study depicted that the hidden Markov model can be used in dynamic risk assessment of natural disaster and future risk levels can be predicted using the present hazard level and the hidden Markov model. Scapini and Zuniga (2020), proposed the use Markov chain to model the cost of housing reconstruction. Barbosa et, al.(2019), scrutinize the application of the Markov chain and standardized precipitation index (SPI) to study the dry and rainy conditions in the sub-region of the Francisco River Basin. The result shows that the recurrence times calculated for the conditions that belong to the semiarid region were smaller when compared to the return period of upper Sao Francisco that has higher levels of precipitation confirming the predisposition of the semi-arid region to present greater chances of the future period of drought. Liu and Stigleir (2021), applied a non-homogeneous Markov process method on multiple lifeline disruptions post-disaster recovery in the industrial sector. The outcome indicates that the restoration of lifeline systems during disruptions should consider each business service given that it significantly affect s business production capacity recovery. Tun and Sein (2019) predict flood conditions for Mone dam, Myanmar using the Markov chain. The study encourages an early warning system that predicts the conditions of the flood using threshold values that are calculated from weather conditions and reservoir water level. Zhang et, al. (2020) analyzed the spillover among the intra-urban housing submarket in Beijing, China using the Markov chain. The study pointed out the effectiveness of policy varies from one case to another where the determinants have not attracted enough attention and deserved further investigation. The result shows that the intra-urban spillover of housing price occurs quite differently compared to the widely studied inter-urban spillover. Chen and Liu (2014) used the Markov chain to estimate the probability of each situation that occurs accurately such that it can reach the next time forecast expectation in demand prediction. The result demonstrates that the model can improve the prediction accuracy and also promote the operability of prediction to a certain level. Kumar et, al.(2013) probe the changes in used land using a Markov model and remote sensing. The result shows that Markov model and geospatial technology together are able to effectively capture the Spatio-temporal trend in the landscape pattern associated with the urbanization of Tirchirap town. Drton et, al. (2003) proposed a non-homogeneous Markov chain based on the increase of tornado activity in the spring and summer months. Tornado activity is modeled with Markov chains for four different geographical points of review. The finding shows that the Markov chain model outperforms climatological forecasts in each of all the performance measures with the exception of forecast reliability, which in the southern tornado alley is inferior to that of the climatological forecast. Espado (2014) examines the financial optimality of disaster risk reduction system measures using the Markov decision process with the geographical information system. The result reveals that the commonwealth government optimized the use of its natural disaster risk reduction expenditures recovered while the government focuses on mitigation. Alexakis et, al. (2014) point out the effects of multi-temporal land-use changes in flood hazards within the Yialias catchment area, central Cyprus. The result denotes the increase of runoff in the catchment area due to the recorded extensive urban sprawl phenomenon of the last decades. Goncalves and Huillet (2020) analyzed total disaster using special Markov chains. The study focus on time reversal, return to the origin, extinction probability scale function, first time to collapse and first passage time, and divisibility property. Basak (2019) proposed Markov chain models of different orders to understand the distribution pattern of Assam and Meghalaya, India.

Since the time and place that disaster happens are most times not known, it is viewed system that consists of random events. As a stochastic process, the Markov chain is used to describe the events that take place randomly. A stochastic process is a Markov process if the occurrence of a future state depends only on the immediately preceding state. Markov chain is a stochastic model explaining a series of possible outcomes in which the probability of each outcome depends on the previous outcome. Tettey et, al. (2017), define the Markov chain as a mathematical method that undergoes a transition from one situation to another with respect to the time in chain-like manner. It is a stochastic

process in which the conditional probability distribution for a state at a particular time to move another state depends only on the current state of the system. Markov chains are classified based on their order. If the probability of occurrence of events in each state depends on the directly previous state only, then it is called the first-order Markov chain. But, if the probability of occurrence of events in the current state depends upon the state in the last two states, then this is said to be the second-order of the Markov chain and so on. Fora better understanding of the Markov chain, there is a need to explain the following terms.

The state probability of an event is the probability of its occurrence at a point in time. Transition probability represents the conditional probability that a system will be in a future state based on an existing state to predict the movement of the system from one state to the next state. These probabilities can be represented as elements of a square matrix or a transition diagram (Taha, 2006). Matrix of transition probabilities comprises all transition probabilities for any given system. Markov chain reaches the steady-state condition if all the transition matrix elements remain positive from one period to the next and can move from one state to another in a finite number of steps regardless of the state(Sharma, 2018).

Mathematical Formulation (Markov chain)

Let(X_t)= x_1, x_2, x_3,…$x_n$be random variable that describes the state of the system at discrete points in time t= t_1,t_2, t_3, . . . t_n such that it possesses the property below

$$P\{Xt_n = x_n/Xt_{n-1} = x_{n-1}, \ldots, X_{t0} = x_0\}= P\{Xt_n=x_n/Xt_{n-1} = x_{n-1}\}$$

Where n are the outcomes.

The probabilities at a specific point in time t = 0, 1, 3, 4, …. can be written as

$$Pij = \{X_t = j/ X_{t-1} = i\}, (ij) =1, 2, 3, 4, ., ., ., ,n$$

$$t = 0, 1, 2, 3, 4, ., ., ., T$$

which is known as one-step transition probability of moving from I at t-1 to state j at t, then

$$\sum_j Pij = 1 \quad I = 1, 2, 3, 4, \ldots n$$

$$Pij \geq 0, (I, j) =1, 2, 3, 4, \ldots n$$

The normal way of writing one-step transition probabilities is to use matrix notation:

$$P = \begin{pmatrix} P_{11} & p_{12} & p_{13} & p_{14} \ldots P_{1n} \\ P_{21} & P_{22} & P_{23} & p_{24} \ldots P_{2n} \\ . & . & \ldots & \\ . & . & . & .. \quad . \\ . & . & . & .. \quad . \\ P_{n1} & P_{n2} & P_{n3} & P_{n4} \ldots P_{nn} \end{pmatrix}$$

Where the matrix **P**is defined as Markov chain. That is it has the property that all its transition probabilities *Pij* are stationary and independent over time.

n- step transition probabilities

Let initial probabilities $a^{(0)} = \{ a_j^{(0)} \}$ of a starting in state j and the transition matrix P of a Markov chain, the absolute probabilities $a^{(n)} = \{ a_j^{(n)} \}$ of being in state j after n transitions (n ≥ 0) the calculated as shown below:

$$a^{(1)} = \{ a^{(0)}\}\mathbf{P}$$

$$a^{(2)} = a^{(1)}\mathbf{P} = a^{(0)}\mathbf{PP} = a^{(0)}\mathbf{P}^2$$

$$a^{(3)} = a^{(2)}\mathbf{P} = a^{(0)}\mathbf{P}^2\mathbf{P} = a^{(0)}\mathbf{P}^3$$

. .

. .

. .

$$a^{(n)} = \mathbf{P}^{n-1}\mathbf{P}$$

The matrix is the n- step transition matrix

Steady- state probabilities and mean return times of Ergodic chains

In an ergodic Markov chain, the steady-state probabilities include:

$$S_j = \lim_{n \to \infty} a_j^{(n)}, \; j= 1, 2, 3 \ldots..$$

The probabilities can be determined from the equation below

$$S = S\mathbf{P}$$

$$\sum_j S_j = 1$$

One of the equations in $\pi = \pi P$ is redundant

The mean first return time or the mean recurrence time is given as

$$\mu_{jj} = \frac{1}{\pi j}, \; j= 1, 2,3, 4 \ldots., n$$

First Passage time

To determine the mean first passage time μ_{ij} for all the location in an m –transition matrix, P, is to use the following matrix-based formula:

$$\| \mu jj \| = (\mathbf{I} - \mathbf{N})^{-1}\mathbf{1}, \; j \neq i$$

Where

I = (m-1) identity matrix

$\mathbf{N_j}$ = transition matrix P less its jth row and jth column of target location j

I= (m-1) column vector with all elements equation to 1

The matrix operation $(\mathbf{I}\text{-}\mathbf{N})^{-1}\mathbf{1}$essentially sums the columns of $(\mathbf{I}\text{-}\mathbf{N})^{-1}$.

Analysis

The locations X of fire outbreak at different years t is characterized by village, Town and City. For year t the stochastic process for the situation can be

$$X_t = \begin{cases} 0, \text{ if the location is in the village} \\ 1, \text{ if the location is in the town }, t = 1, 2, 3, \ldots\ldots \\ 2, \text{ if the location is in the city} \end{cases}$$

$X_{t=}$ 0, 1, 2, 3, ….. t

Village	town	city	total
Village30	70	100	**200**
Town130	180	200	**510**
city230	290	350	**870**
Total	**420**	**540** **650**	**1800**

The conditional probability can be obtained by

	village	town	city	total
village	30/200	70/200	100/200	**200/ 200**
town	120/510	170/510	220/510	**510/510**
city	230/870	290/870	350/870	**870/ 870**
Total	**380/1580**	**530/1580**	**670/1580**	**1580/1580**

Therefore

village	town	city	**total**
village	0.15	0.35	0.50 **1**
town	0.24	0.33	0.43 **1**
city	0.26	0.33	0.40 **1**
Total	**0.24**	**0.34**	**0.42 1**

Locations of the system next

State of

P_{ij} = the system

this year

$$\begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

$$P=\begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

The absolute transition probabilities of the three states of the system after 1, 8 and 16

$$P^2 = \begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}\begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

$$= \begin{pmatrix} 0.2365 & 0.3330 & 0.4255 \\ 0.2270 & 0.3349 & 0.4339 \\ 0.2220 & 0.3319 & 0.4319 \end{pmatrix}$$

$$P^4 = \begin{pmatrix} 0.2365 & 0.3330 & 0.4255 \\ 0.2270 & 0.3349 & 0.4339 \\ 0.2220 & 0.3319 & 0.4319 \end{pmatrix}\begin{pmatrix} 0.2365 & 0.3330 & 0.4255 \\ 0.2270 & 0.3349 & 0.4339 \\ 0.2220 & 0.3319 & 0.4319 \end{pmatrix}$$

$$= \begin{pmatrix} 0.2260 & 0.3314 & 0.4288 \\ 0.2260 & 0.3317 & 0.4293 \\ 0.2237 & 0.3284 & 0.4250 \end{pmatrix}$$

$$P^8 = \begin{pmatrix} 0.2260 & 0.3314 & 0.4288 \\ 0.2260 & 0.3317 & 0.4293 \\ 0.2237 & 0.3284 & 0.4250 \end{pmatrix}\begin{pmatrix} 0.2260 & 0.3314 & 0.4288 \\ 0.2260 & 0.3317 & 0.4293 \\ 0.2237 & 0.3284 & 0.4250 \end{pmatrix}$$

$$= \begin{pmatrix} 0.2219 & 0.3256 & 0.4214 \\ 0.2220 & 0.3259 & 0.4217 \\ 0.2198 & 0.3226 & 0.4175 \end{pmatrix}$$

$$P^{16} = \begin{pmatrix} 0.2219 & 0.3256 & 0.4214 \\ 0.2220 & 0.3259 & 0.4217 \\ 0.2198 & 0.3226 & 0.4175 \end{pmatrix} \begin{pmatrix} 0.2219 & 0.3256 & 0.4214 \\ 0.2220 & 0.3259 & 0.4217 \\ 0.2198 & 0.3226 & 0.4175 \end{pmatrix}$$

$$= \begin{pmatrix} 0.2141 & 0.3143 & 0.4067 \\ 0.2143 & 0.3145 & 0.4070 \\ 0.2121 & 0.3113 & 0.4029 \end{pmatrix}$$

But

$$P = \begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

Hence,

$a^{(1)} = a^{(0)}\mathbf{P}$

$$= (1, 0, 0) \begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

$$= (0.15\ 0.35\ 0.15)$$

$a^{(2)} = a^{(0)}\mathbf{P^2}$

$$= (1, 0, 0) \begin{pmatrix} 0.2365 & 0.3330 & 0.4255 \\ 0.2270 & 0.3349 & 0.4339 \\ 0.2220 & 0.3319 & 0.431 \end{pmatrix}$$

$$= (0.2363\ 0.3330\ 0.4363)$$

$a^{(4)} = a^{(0)}\mathbf{P^4}$

$$= (1, 0, 0) \begin{pmatrix} 0.2260 & 0.3314 & 0.4288 \\ 0.2260 & 0.3317 & 0.4293 \\ 0.2237 & 0.3284 & 0.4250 \end{pmatrix}$$

$$= (0.226\ 0.3314\ 0.4288)$$

$a^{(8)} = a^{(0)}\mathbf{P^8}$

$$= (1, 0, 0) \begin{pmatrix} 0.2219 & 0.3256 & 0.4214 \\ 0.2220 & 0.3259 & 0.4217 \\ 0.2198 & 0.3226 & 0.4175 \end{pmatrix}$$

$$= (0.2219\ 0.3256\ 0.4288)$$

$a^{(16)} = a^{(0)}\mathbf{P^{16}}$

$$= (1, 0, 0) \begin{pmatrix} 0.2141 & 0.3143 & 0.4067 \\ 0.2143 & 0.3145 & 0.4070 \\ 0.2121 & 0.3113 & 0.4029 \end{pmatrix}$$

$$= (0.2141\ 0.3143\ 0.4067)$$

The row P^n and the vector of absolute probabilities $a^{(n)}$. This shown that as the number of transitions increases, the absolute probabilities are independent of the initial $a^{(0)}$.

Determine steady-state probability distribution of the size and location problem with fire outbreak,we have

$$(S_1\ S_2\ S_3) = (S_1\ S_2\ S_3) \begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26 & 0.33 & 0.40 \end{pmatrix}$$

Producing the following equations:

$S_1 = 0.15S_1 + 0.24S_2 + 0.26S_3$ 1

$S_2 = 0.35S_1 + 0.33S_2 + 0.43S_3$ 2

$S_3 = 0.50S_1 + 0.43S_2 + 0.40S_3$ 3

$S_1 + S_2 + S_3 = 1$ 4

Remember that the number three of the equation is redundant, the solution is $S_1=0.2275$, $S_2 = 0.3744$, and $S_3 = 0.3981$. What these probabilities say is that fire outbreak takes place in the village killing 23% of the population at that time, when the fire outbreak occur in the town killing 37% of the entire population at that particular year or time and fire outbreak occur in the city claiming 40% of the entire population at that particular year or time.

The mean first return time are calculated as

$\mu_{11} = 1/0.2275 = 4.3956$

$\mu_{22} = 1/0.3744 = 2.6709$

$\mu_{33} = 1/0.3981 = 2.6247$

This implies that, based on the present sizes and location that the fire disaster occur, it will take 2 years for fire disaster to occur in the village, 3 years for fire disaster to happen in the city and 3 years for fire disaster to occur in the city.

First Passage time

let

$$P = \begin{pmatrix} 0.15 & 0.35 & 0.50 \\ 0.24 & 0.33 & 0.43 \\ 0.26.1 & 0.33 & 0.40 \end{pmatrix}$$

To calculate the first passage time to a specific location from all others, consider the passage from town and city to village, we use the formula:

$$(I-N_1)^{-1} = \left\{ \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 0.33 & 0.43 - \\ 0.33 & 0.40 \end{pmatrix}^{-1} \right\}$$

$$= \begin{pmatrix} 0.67 & -0.43^{-1} \\ -0.33 & 0.6 \end{pmatrix}$$

$$= \begin{pmatrix} 2.3068 & 1.6532 \\ 1.2687 & 2.559 \end{pmatrix}$$

Thus,

$$\begin{pmatrix} \mu_{21} \\ \mu_{31} \end{pmatrix} = \begin{pmatrix} 2.3068 & 1.65321 \\ 1.2687 & 2.5591 \end{pmatrix}$$

$$= \begin{pmatrix} 142.368 \\ 79.945 \end{pmatrix}$$

This shows that based on the average, it takes 142 years to pass from town to city and 80 years to pass from village to city.

To calculate the second passage time to a specific location from all others consider the from village and city to town.

$$(I-N_2)^{-1} = \left[\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} - \begin{pmatrix} 0.15 & 0.50^{-1} \\ 0.27 & 0.40 \end{pmatrix} \right]$$

$$= \begin{pmatrix} 0.85 & -0.50^{-1} \\ -0.27 & 0.60 \end{pmatrix}$$

$$= \begin{pmatrix} 1.6 & 1.3333 \\ 0.72 & 2.2666 \end{pmatrix}$$

Thus,

$$= \begin{pmatrix} \mu_{12} \\ \mu_{32} \end{pmatrix} \begin{pmatrix} 1.6 & 1.33331 \\ 0.72 & 2.26661 \end{pmatrix}$$

$$= \begin{pmatrix} 2.9333 \\ 2.966 \end{pmatrix}$$

This implies that based on the average, it takes 2.93 years to pass fromvillage to city and 2.99 years to pass from town to city.

To calculate the third passage time to a specific location from all others consider from villageand town tocity.

$$(I-N_3)^{-1} = \left[\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} - \begin{pmatrix} 0.15 & 0.35 \\ 0.24 & 0.33 \end{pmatrix} \right]$$

$$= \begin{pmatrix} 0.85 & -0.35 \\ -0.24 & 0.67 \end{pmatrix}^{-1}$$

$$= \begin{pmatrix} 1.3800 & 0.7209 \\ 0.4943 & 1.75071 \end{pmatrix}$$

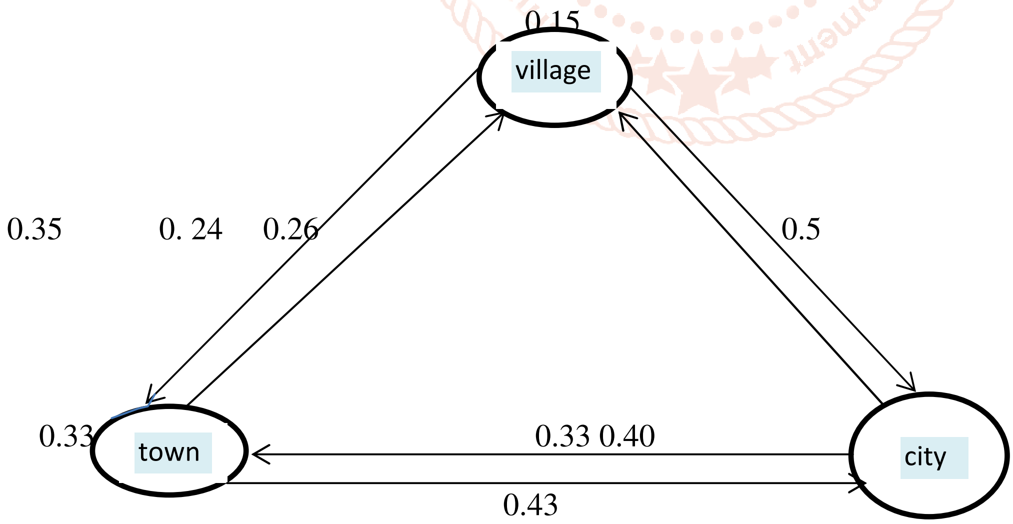
Thus,

$$= \begin{pmatrix} \mu_{13} \\ \mu_{23} \end{pmatrix} \begin{pmatrix} 1.3800 & 0.72091 \\ 0.4943 & 1.75071 \end{pmatrix}$$

$$= \begin{pmatrix} 2.1009 \\ 2.2450 \end{pmatrix}$$

This implies that based on the average, it take 2.10 years to pass from village to big and 2.25 years to pass from city to city.

The Transition Diagram



0.43

Interpretation of result

In terms of percentage, a fire outbreak can occur in a village claiming 15% of the population, when the same fire outbreak occur in the town, it claims 35% of the entire population and takes place in the city with the same magnitude claims 50% of the population in a particular year. When the fire disaster occurs in the town, 33% of the entire population were found dead, when a fire of the same magnitude occurs in the village, it claims 24% of the entire population while the fire of the magnitude occurs in the city, it claims 43% of the entire population in a particular year. Whenever a fire outbreak occurs in the city, it claims 40% of the population, while the fire of the magnitude that occurs in the town burn 33% of the entire population to death and when it occurs in the village, it claims 26% of the entire population in a particular year.

Summary of findings

From the above analysis, we discovered that disasters occur unexpectedly the people involved in danger. The study revealed that fire outbreaks can occur in any place and at a different magnitude, therefore, everybody has to be on guard. The finding also revealed that places that have experience fire disasters will still experience in the future if not properly managed.

Conclusion

The random occurrence of disasters like fire outbreaks makes the Markov chain model more suitable for the study. Fire disaster takes place in different parts of the world with its effects based on the size and location. Based on the finding, there is no adequate dissemination of information in respect to fire disasters, therefore, leading to poor preparation. Therefore, there is a need for the various stakeholders to come together and make a decision regarding fire disaster prevention and management thereby removing the risk involved in fire disaster and reduction of damage cost irrespective of the location and the magnitude of the fire. We recommended that the government should create awareness through advertisement programs, training centers, seminars and encourage the integration of fire disasters into the school curriculum to ensure sufficient and effective fire disaster mitigation and management.

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